The single-pulse investigation of PSR J2222-0137

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Introduction: PSR J2222-0137

A pulsar with $P = 32.8$ ms in a 2.44-day binary system, DM=3.28 pc cm^{-3}

$\dot{P} \sim 10^{-20}$ implies: **a middly recycled process**

$e = 0.00038$ implies: the companion is a white dwarf (WD) star

Orbital model	DDGR
Weighted residual rms (μs)	2.759
χ^2	10629.32
Reduced χ^2	0.9934
Orbital period, P_b (days)	2.44576436(2)
Projected semi-major axis, x (lt-s)	10.84802354(10)
Epoch of periastron, T_0 (MJD)	58002.019280(10)
Orbital eccentricity, e	0.00038092(1)
Longitude of periastron, ω (deg)	120.458(1)
Total mass, M_{tot} ($M_\odot$)	3.135(19)
Companion mass, M_c ($M_\odot$)	1.3153(56)
Rate of advance of periastron, $\dot{\omega}$ (deg yr^{-1})	-
Derivative of P_b, $\dot{P}_b$ (10^{-12} s s^{-1})	0.2634(74)[a]
Derivative of x, $\dot{x}$ (10^{-15} lt-s s^{-1})	−7.76(48)
Orbital inclination (deg)	-
Position angle of line of nodes, Ω (deg)	-
Derived parameters	
Mass function, f ($M_\odot$)	0.229142359(10)
Pulsar mass, M_p ($M_\odot$)	1.820(14)

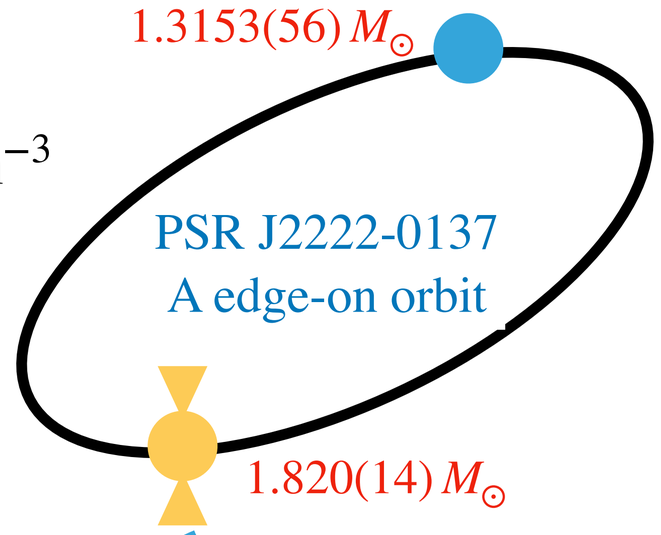
2009/06/23

↓

2021/05/02

The **most massive** double degenerate binary known in the Galaxy.

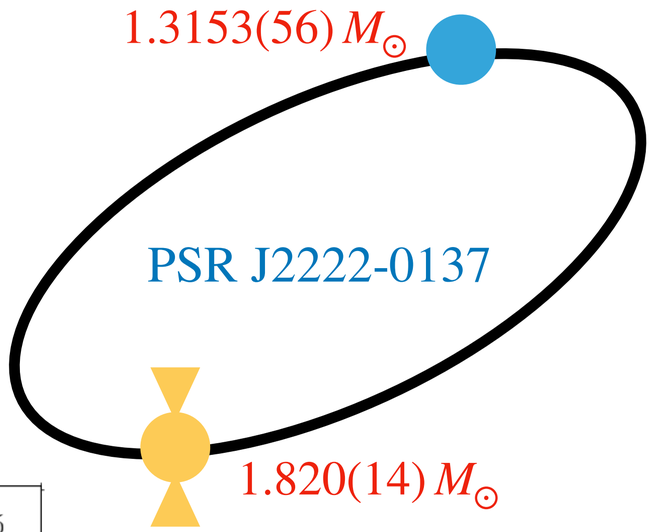
Guo et al. A&A (2021)



Green Bank Telescope (GBT)
350 MHz drift-scan pulsar survey

PSR J2222-0137: the ideal laboratory of scalar-tensor theories

- The large difference in the compactness of the components of PSR J2222-0137: PSR-WD system
- A more precision mass measurement
- In an intermediate, previous unexplored mass range



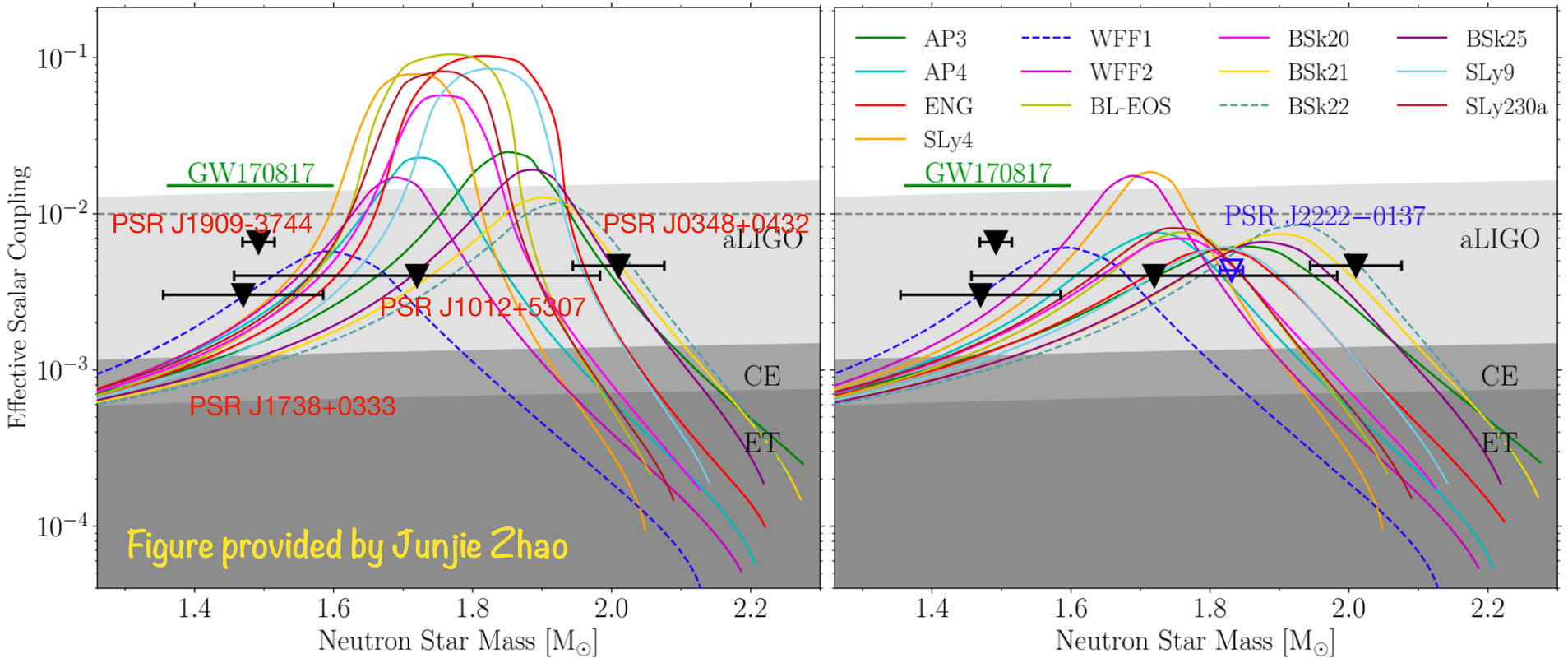
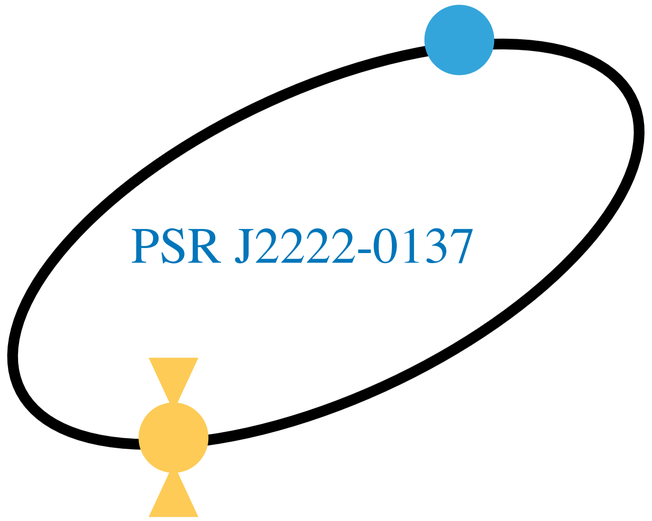


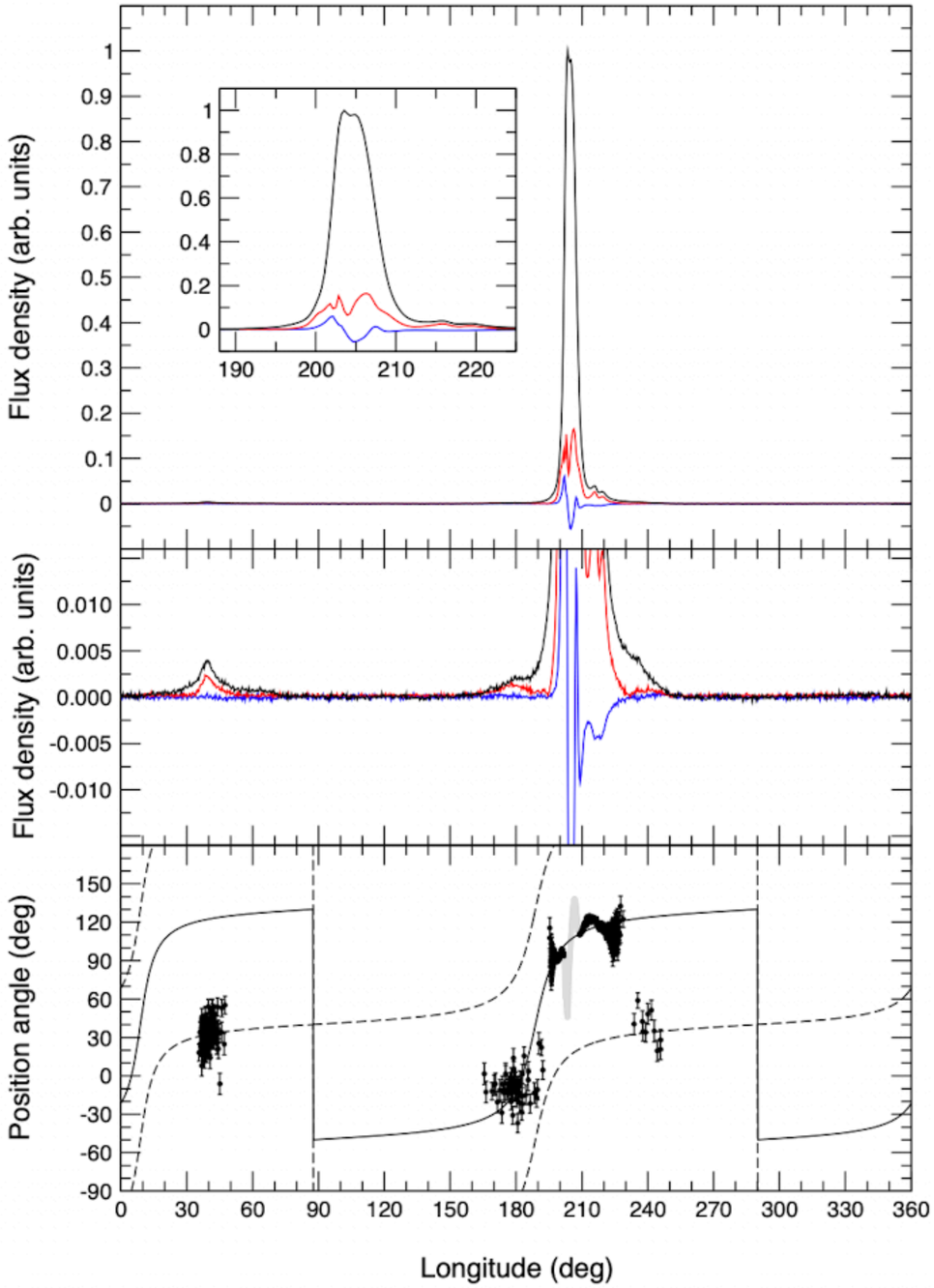
Figure provided by Junjie Zhao

PSR J2222-0137 & FAST



Reveals the existence of an **interpulse**

High SNR observation



Guo et al. A&A (2021)

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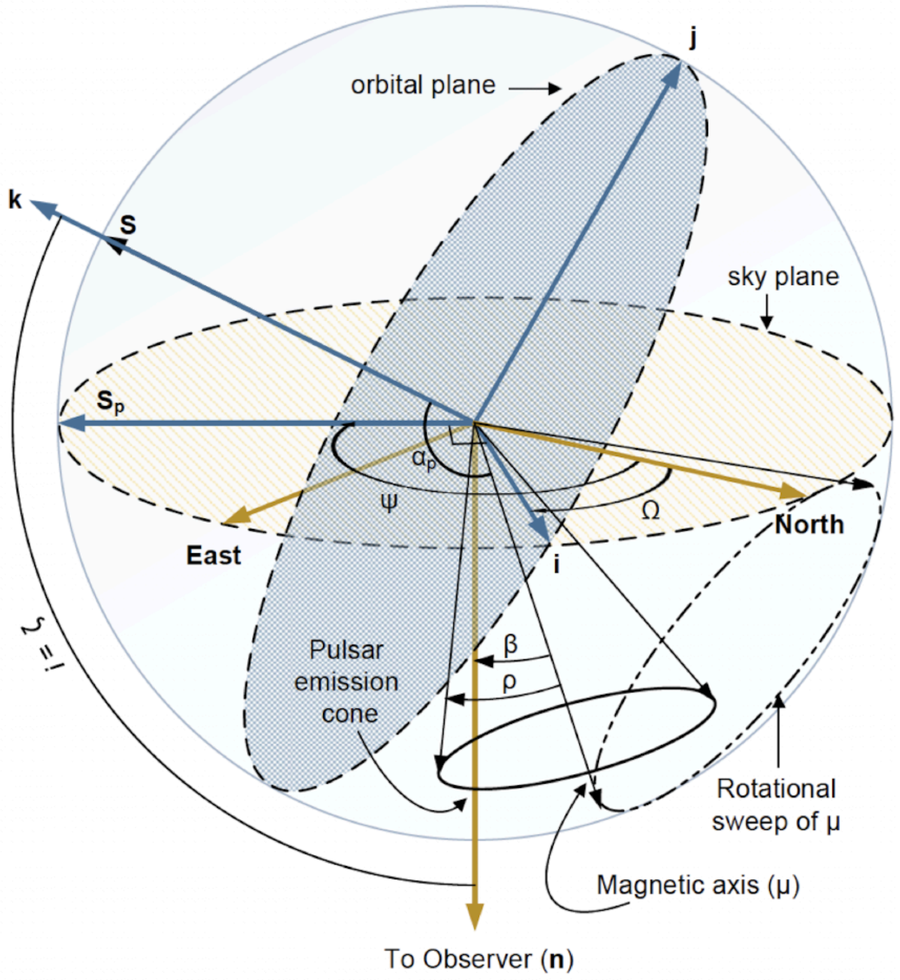
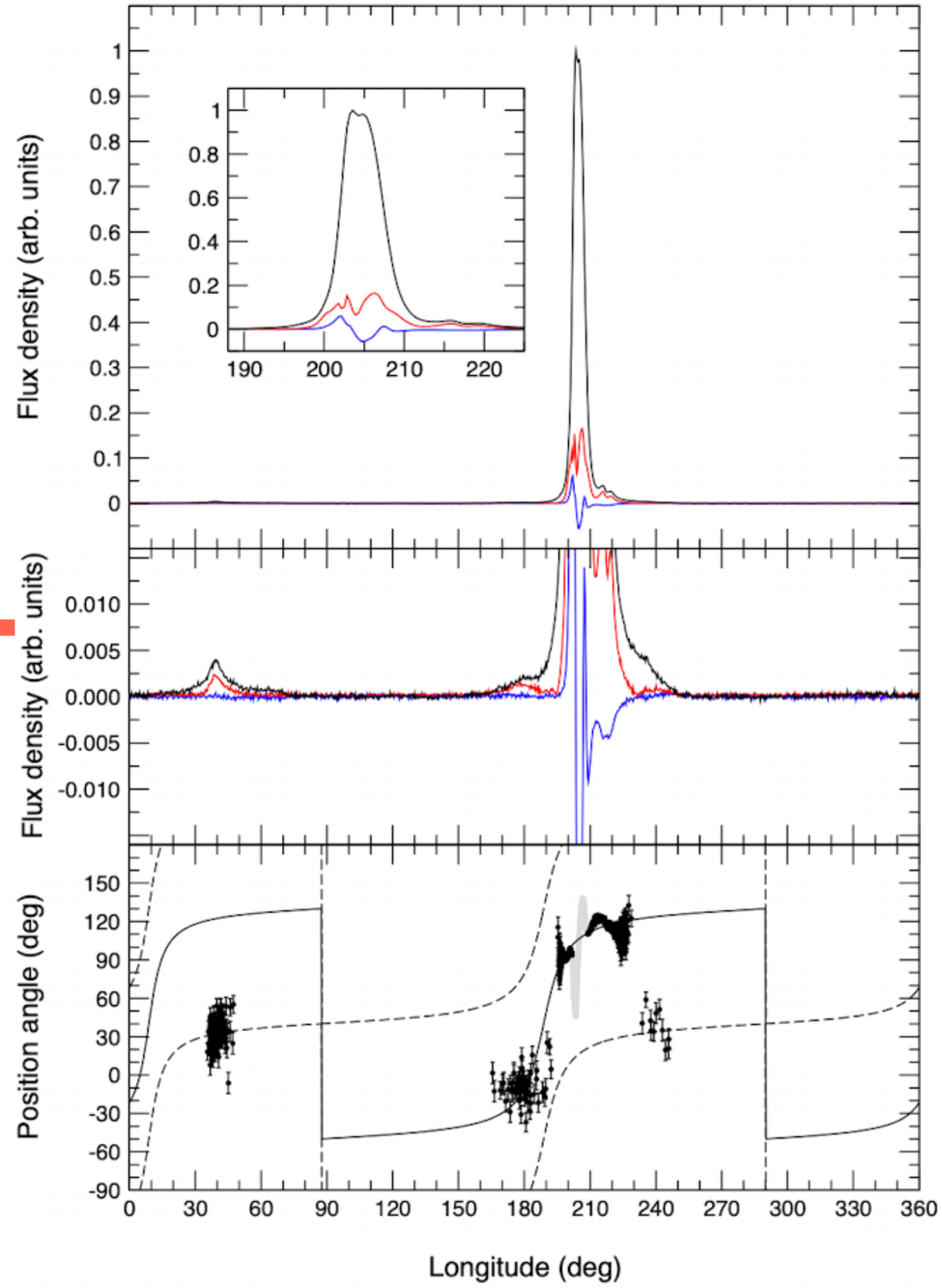


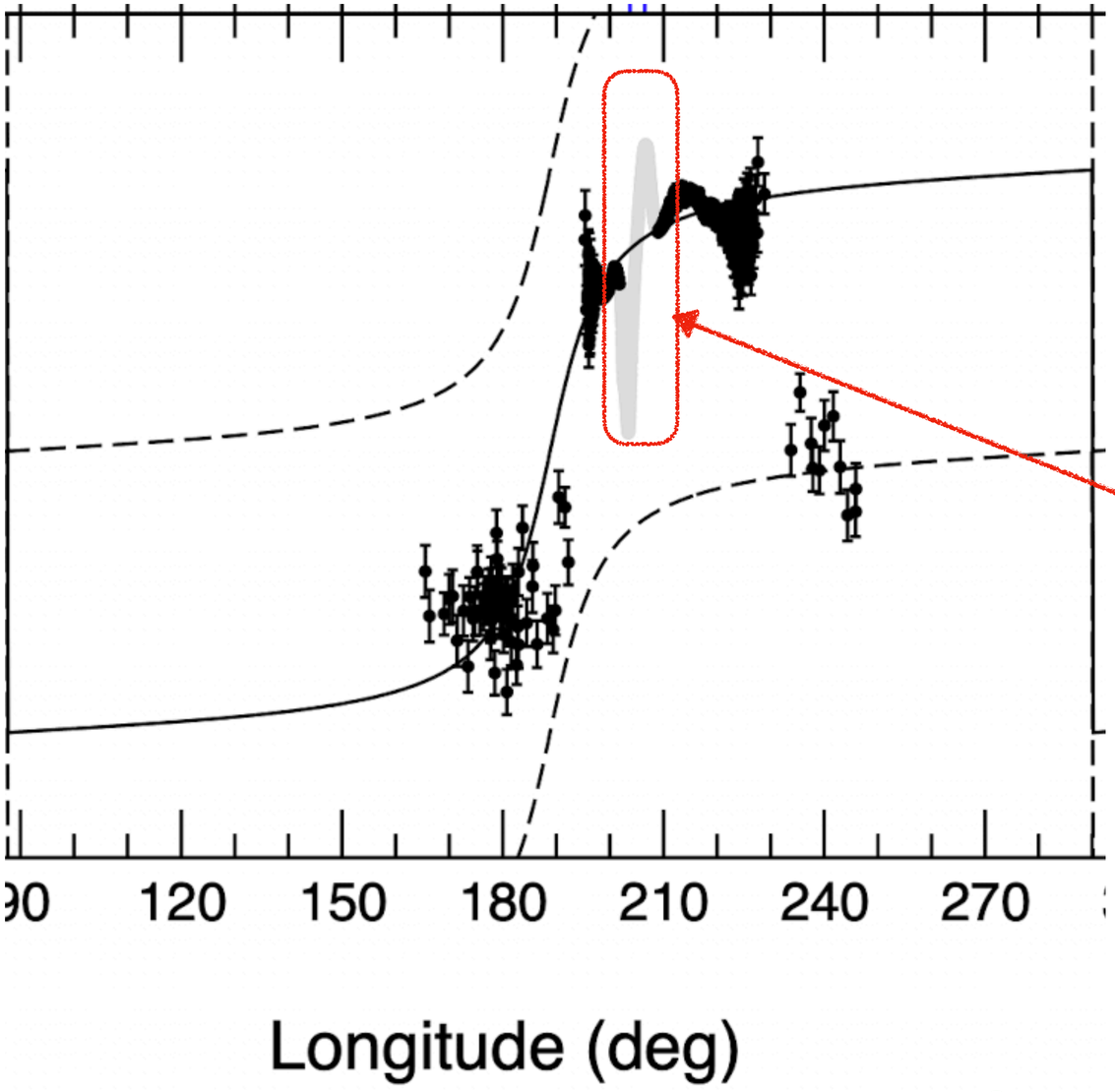
$$i = 85.27(4)\ \text{deg}$$
$$\Omega = 189^{+19}_{-18}\ \text{deg}$$

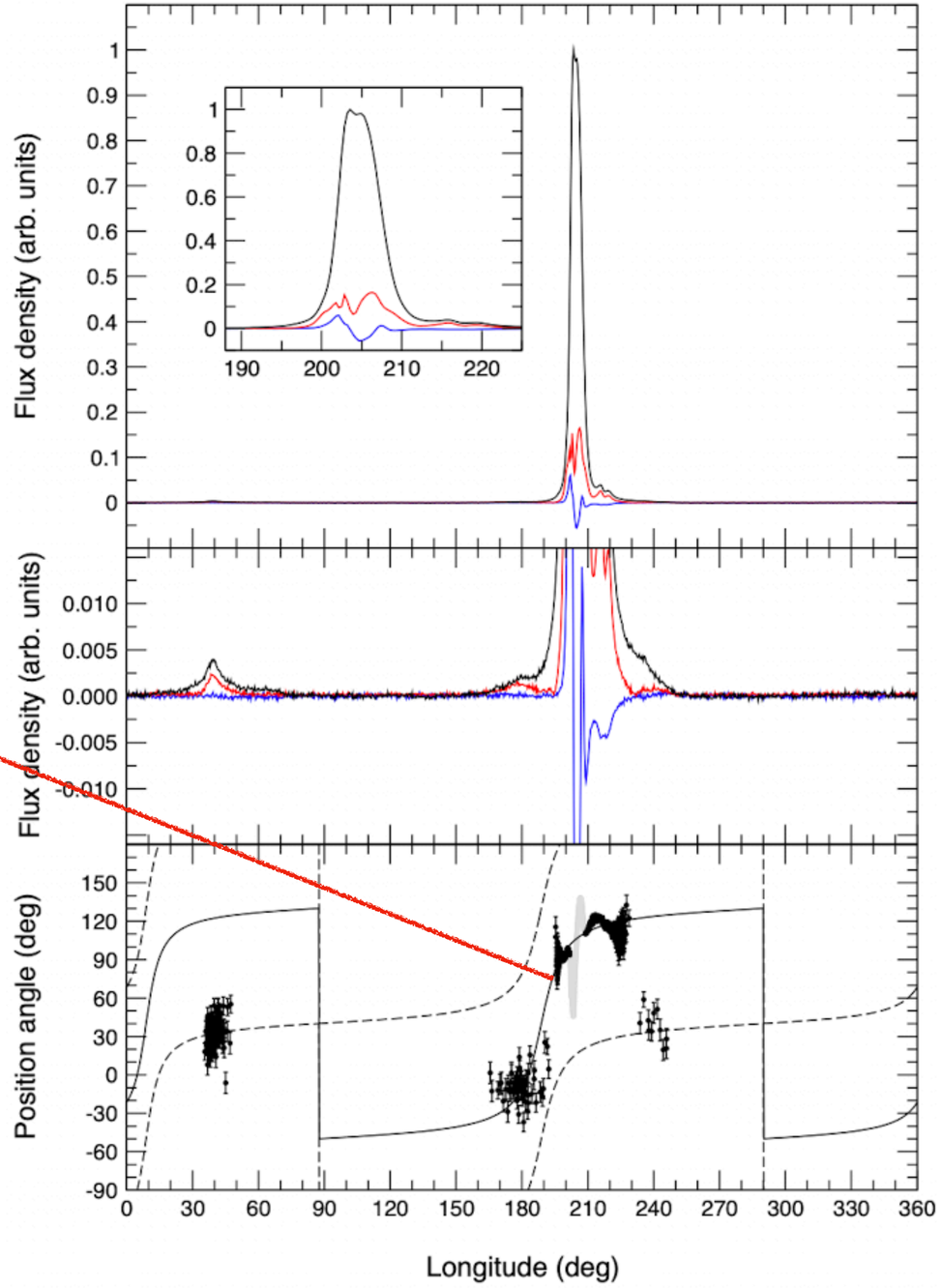
$$\alpha = 77(1)\ \text{deg}$$
$$\beta = -7.2(6)\ \text{deg}$$



Guo et al. A&A (2021)

PSR J2222-0137 & FAST





Guo et al. A&A (2021)

PSR J2222-0137 single pulses

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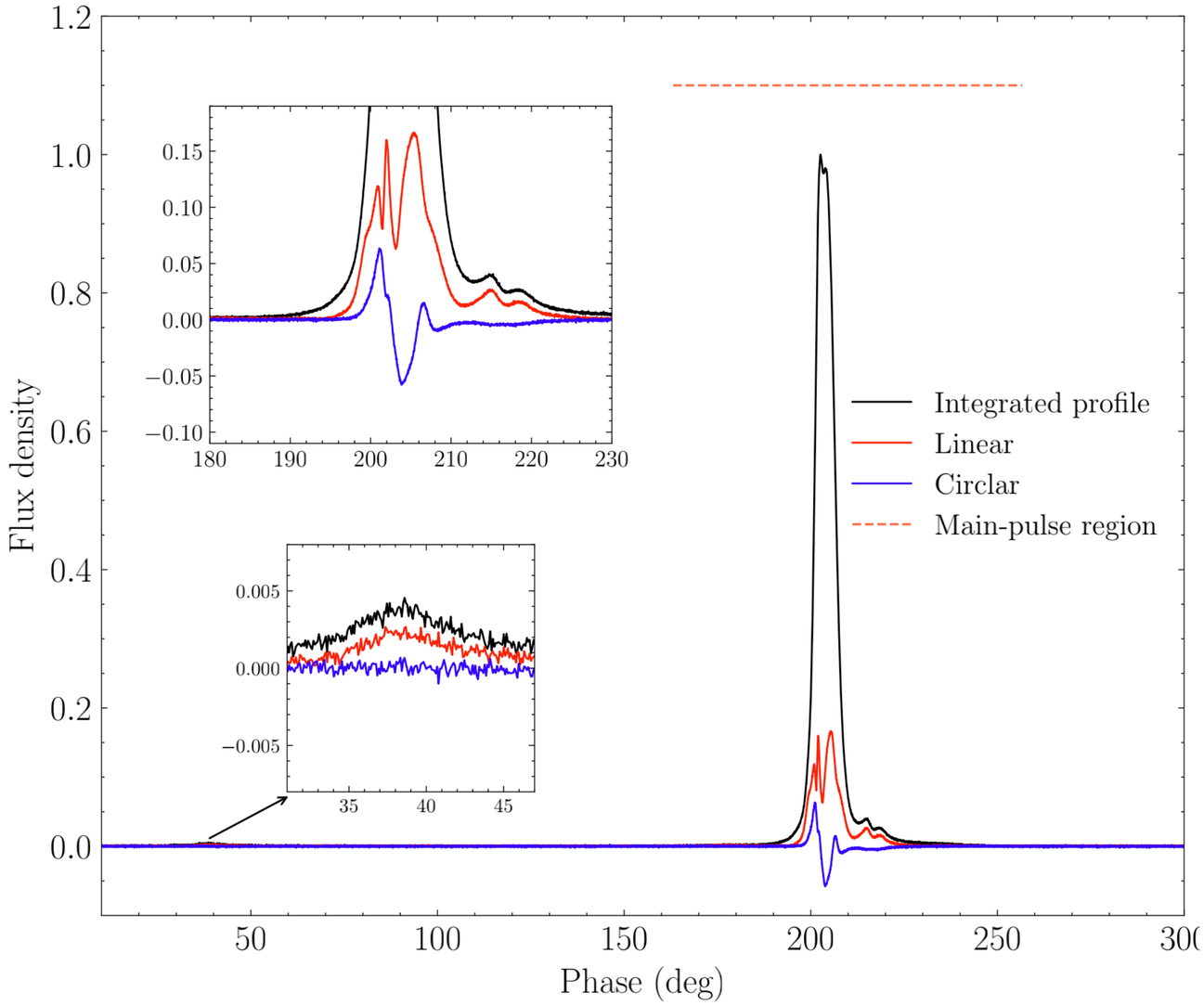
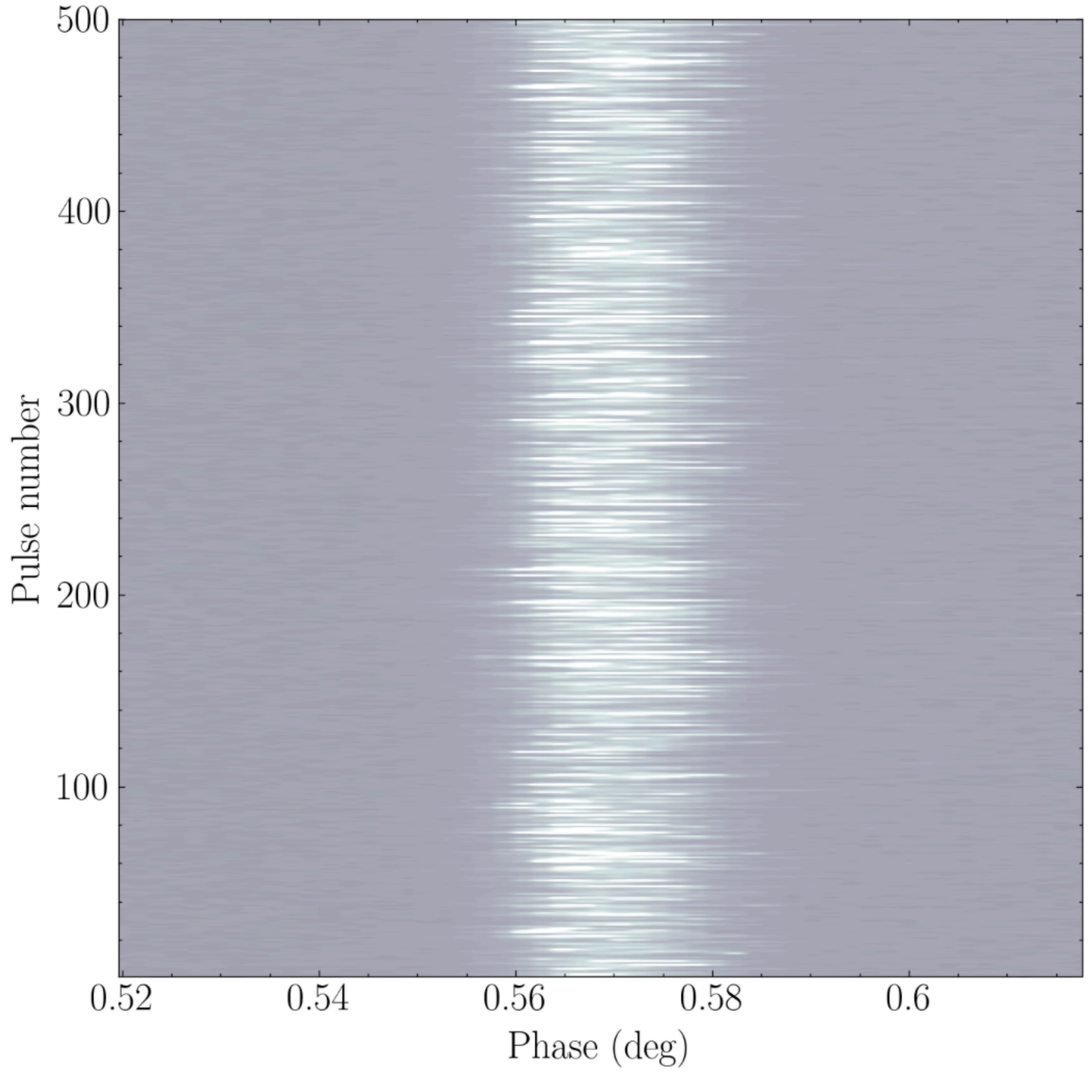
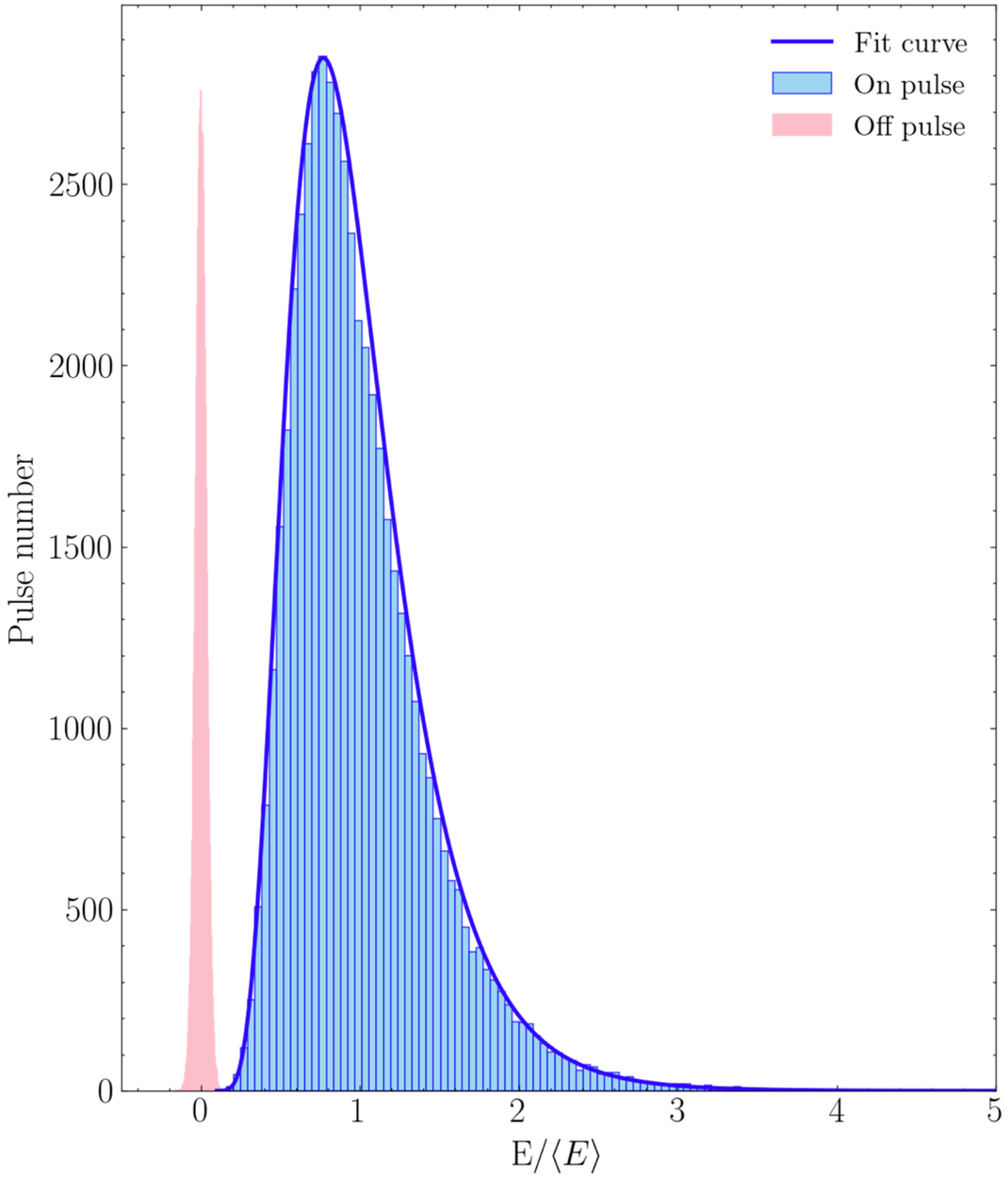
PSR J2222-0137 30min data, integration profile SNR = 23014.9, total 52692 pulses

1000Mhz-1500Mhz (4096 frequency channels), time resolution $49.152\,\mu$s, 512 phase bin,

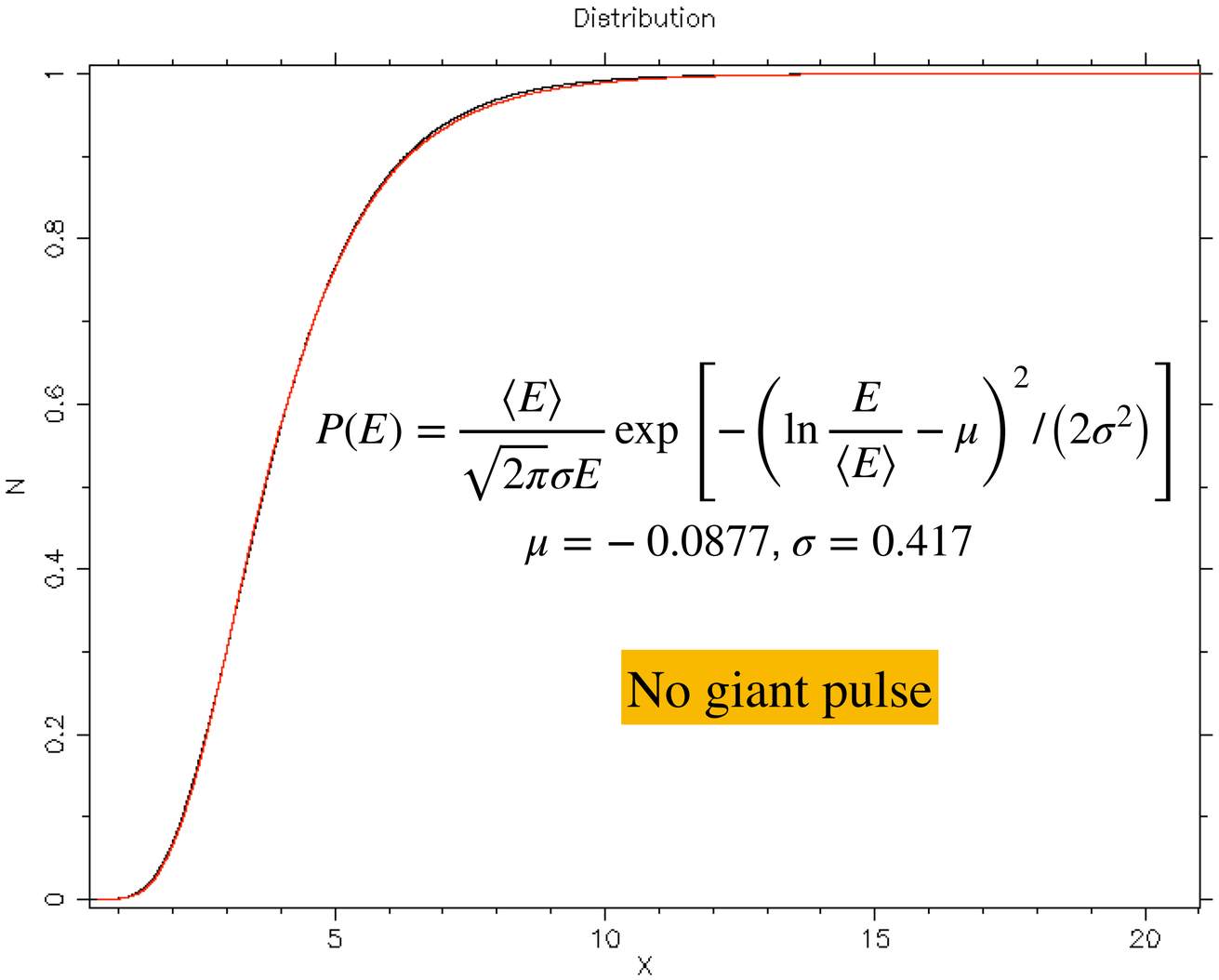




PSR J2222-0137 single pulses energy distribution



PSRSALSA fit result:



$$P(E) = \frac{\langle E \rangle}{\sqrt{2\pi}\sigma E} \exp\left[-\left(\ln\frac{E}{\langle E \rangle} - \mu\right)^2 / (2\sigma^2)\right]$$

$$\mu = -0.0877, \sigma = 0.417$$

No giant pulse

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PSR J2222-0137 single pulses polarization

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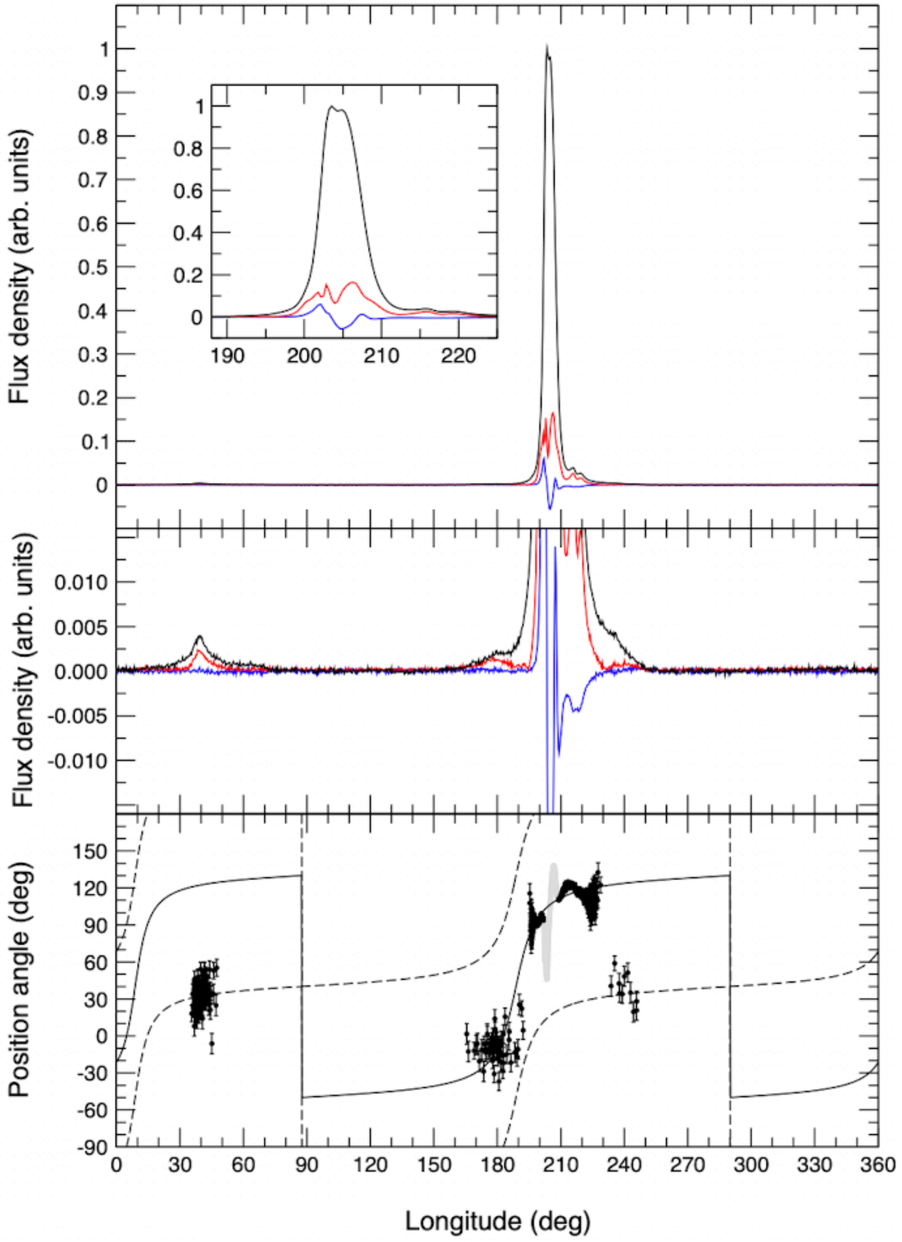
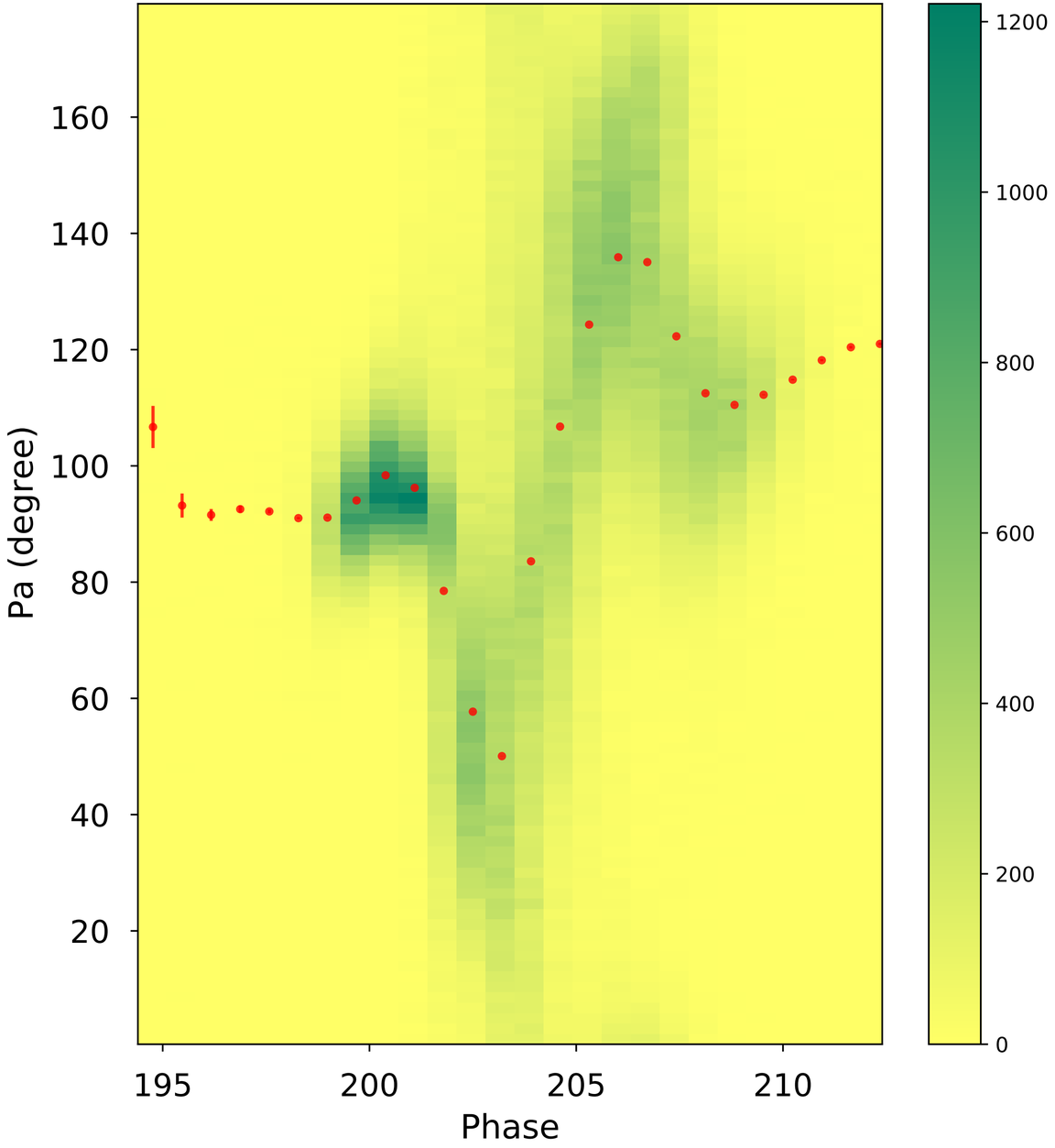
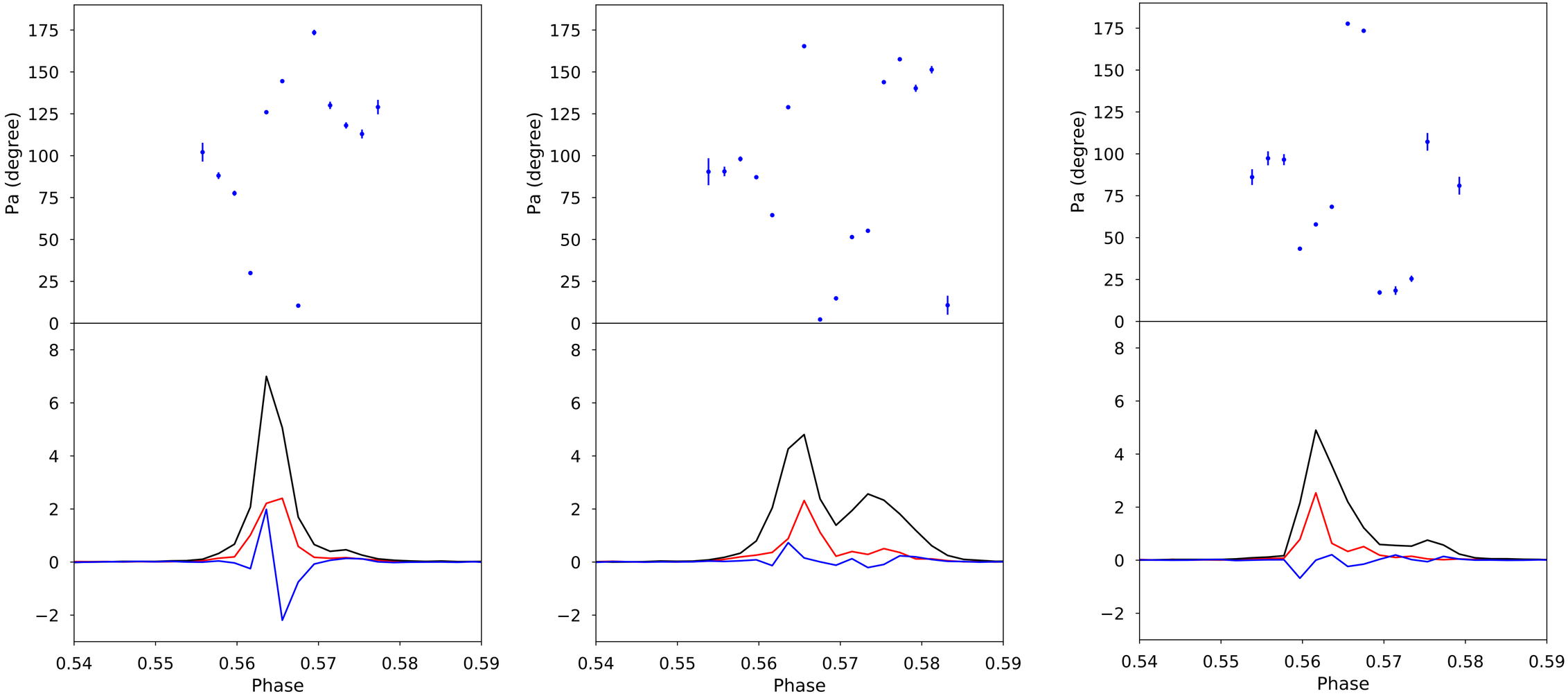




PSR J2222-0137 single pulses polarization



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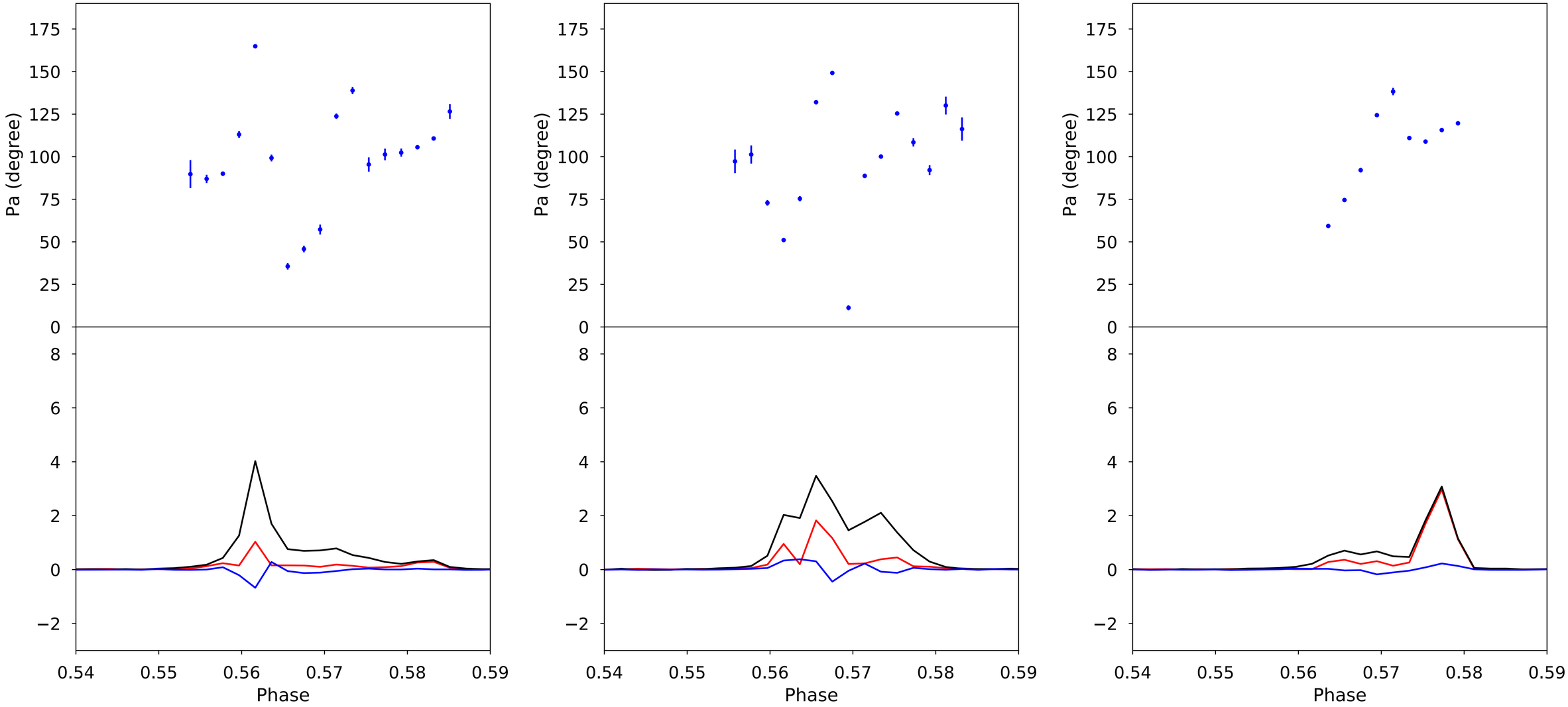
PSR J2222-0137 single pulses polarization



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The variability of single pulses of PSR J2222-0137

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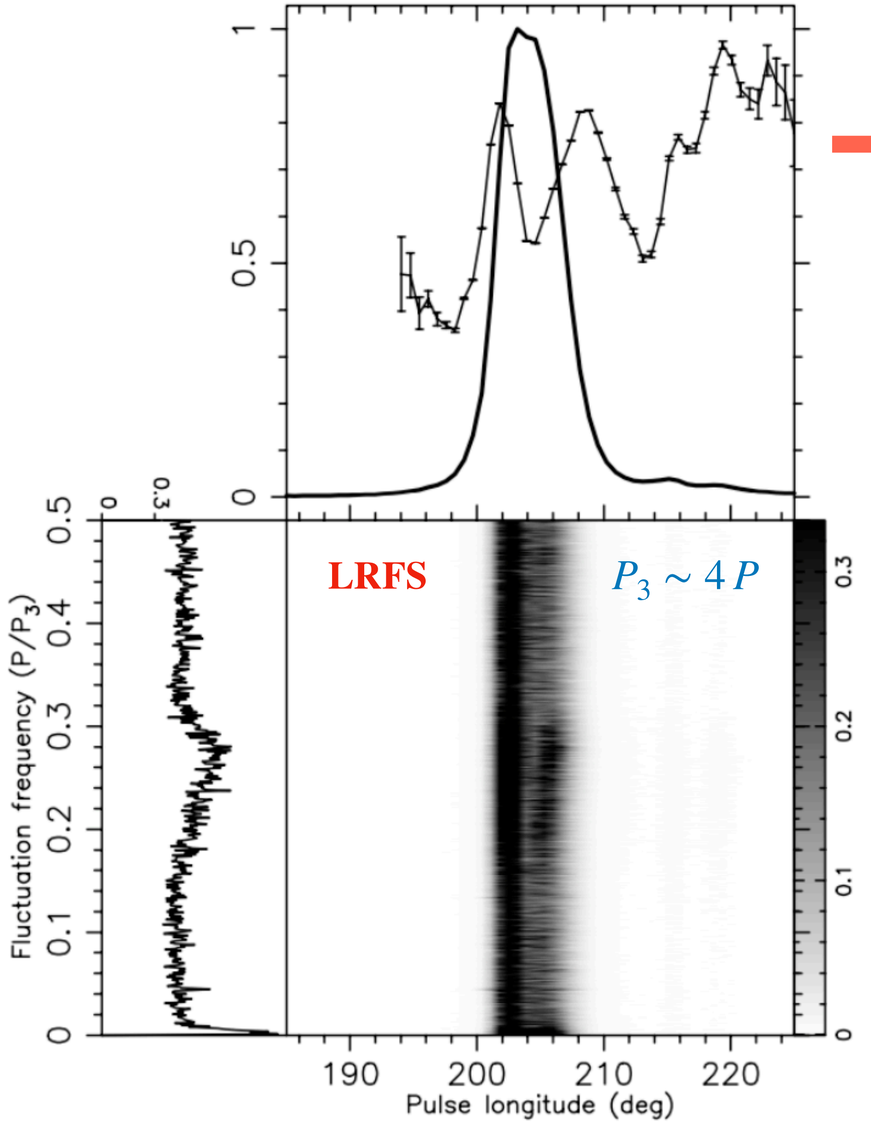
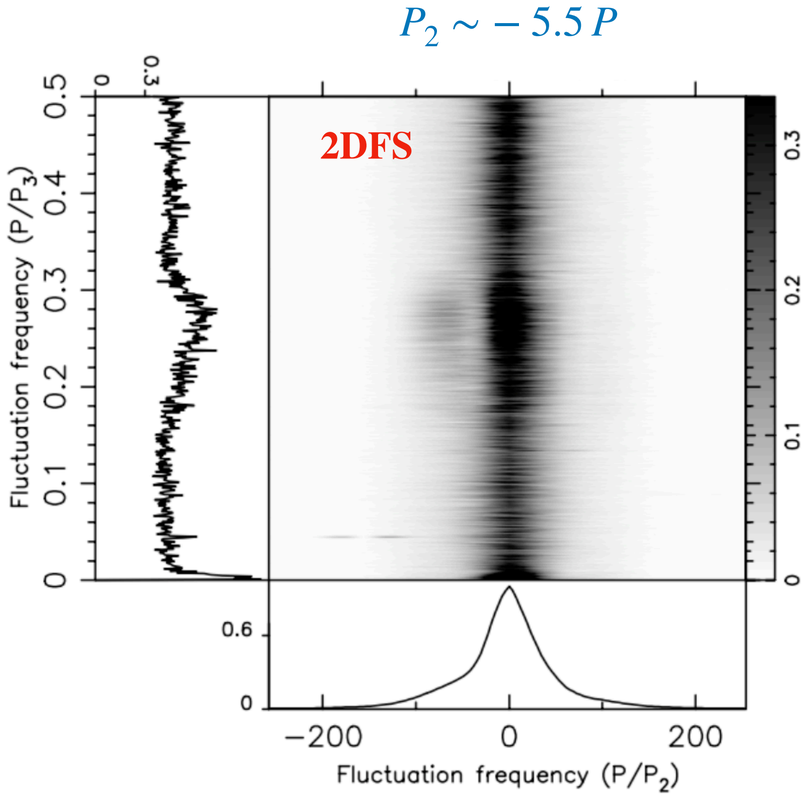
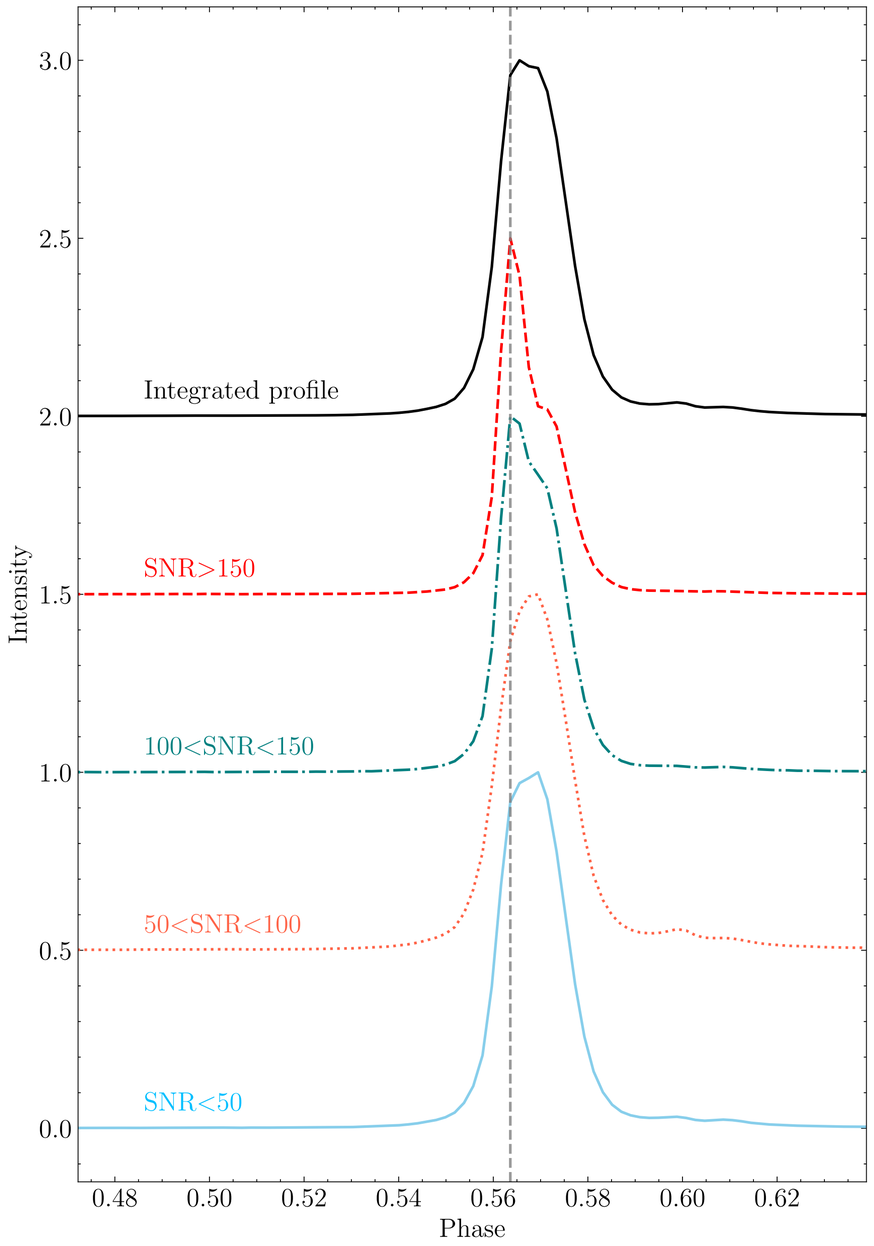
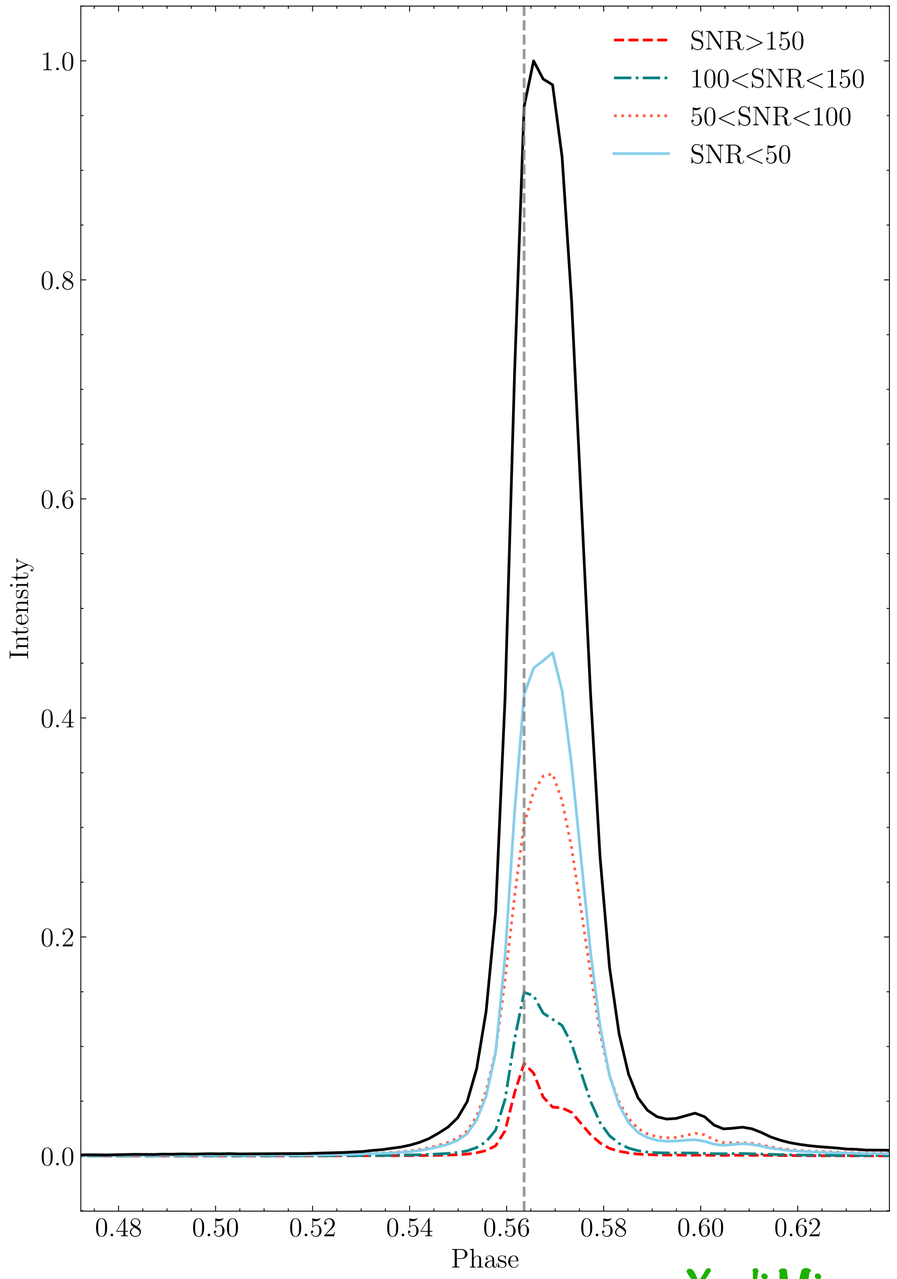


$$m_{i,\,\mathrm{on}} = \frac{\sqrt{\sigma_{i,\,\mathrm{on}}^2 - \sigma_{\mathrm{off}}^2}}{I_{i,\,\mathrm{on}}}$$

$P_2 \sim -5.5\,P$







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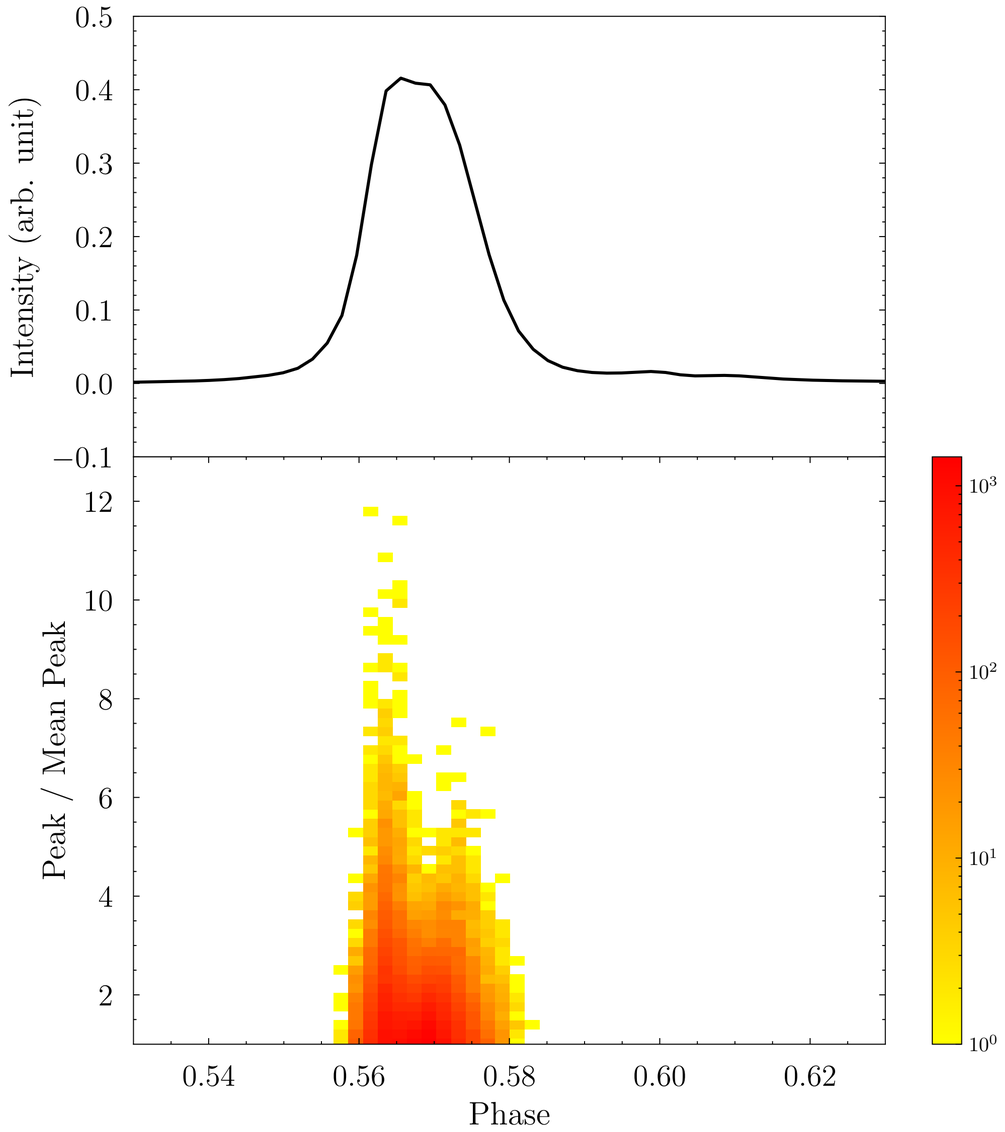

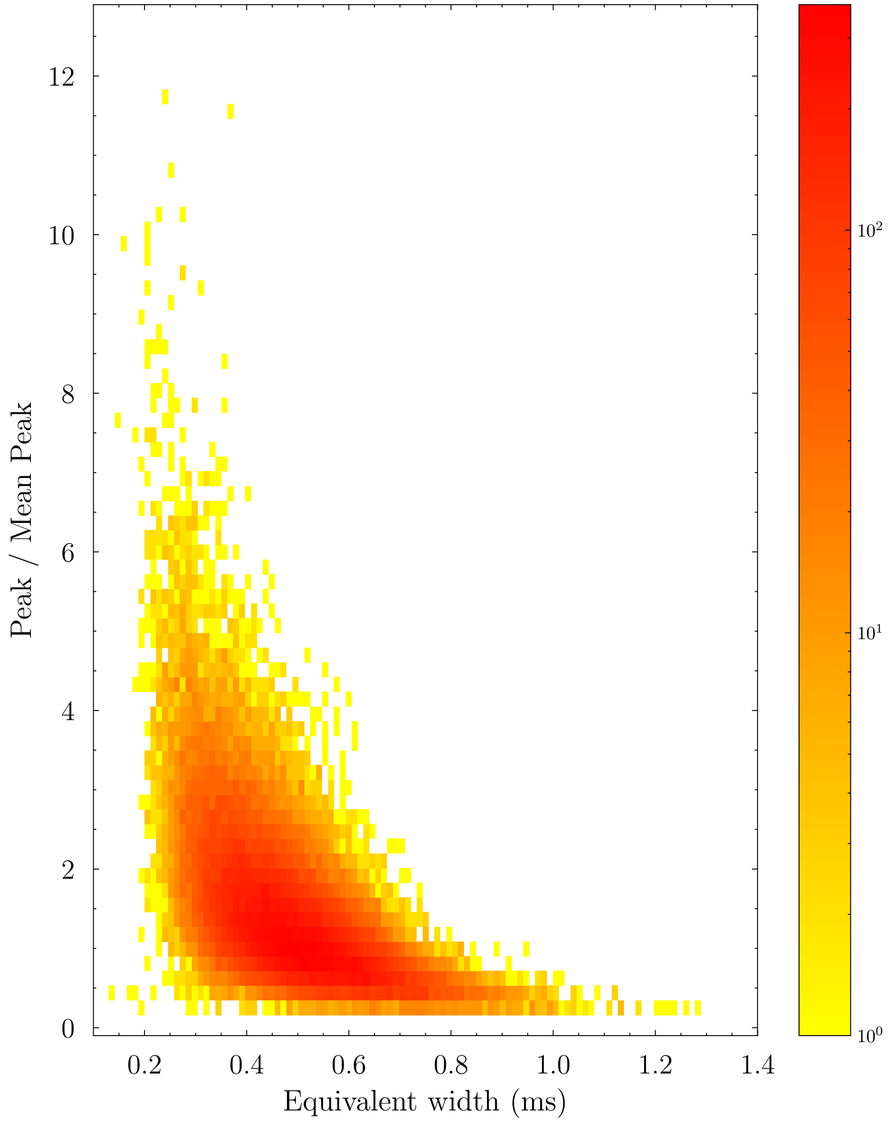

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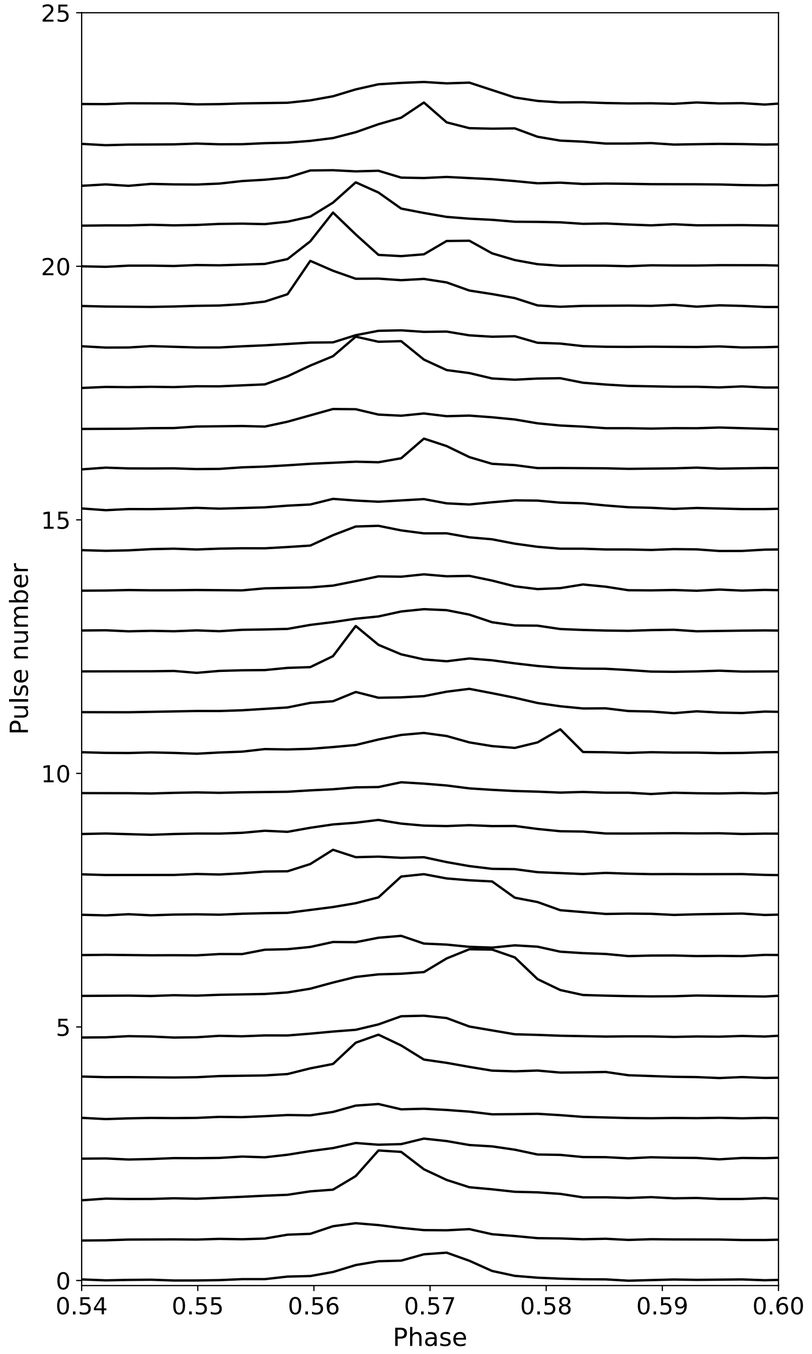
Jitter analysis of PSR J2222-0137

$$\sigma_{\rm obs}^2 = \sigma_{\rm rn}^2 + \sigma_{\rm J}^2 + \sigma_{\rm sc}^2$$



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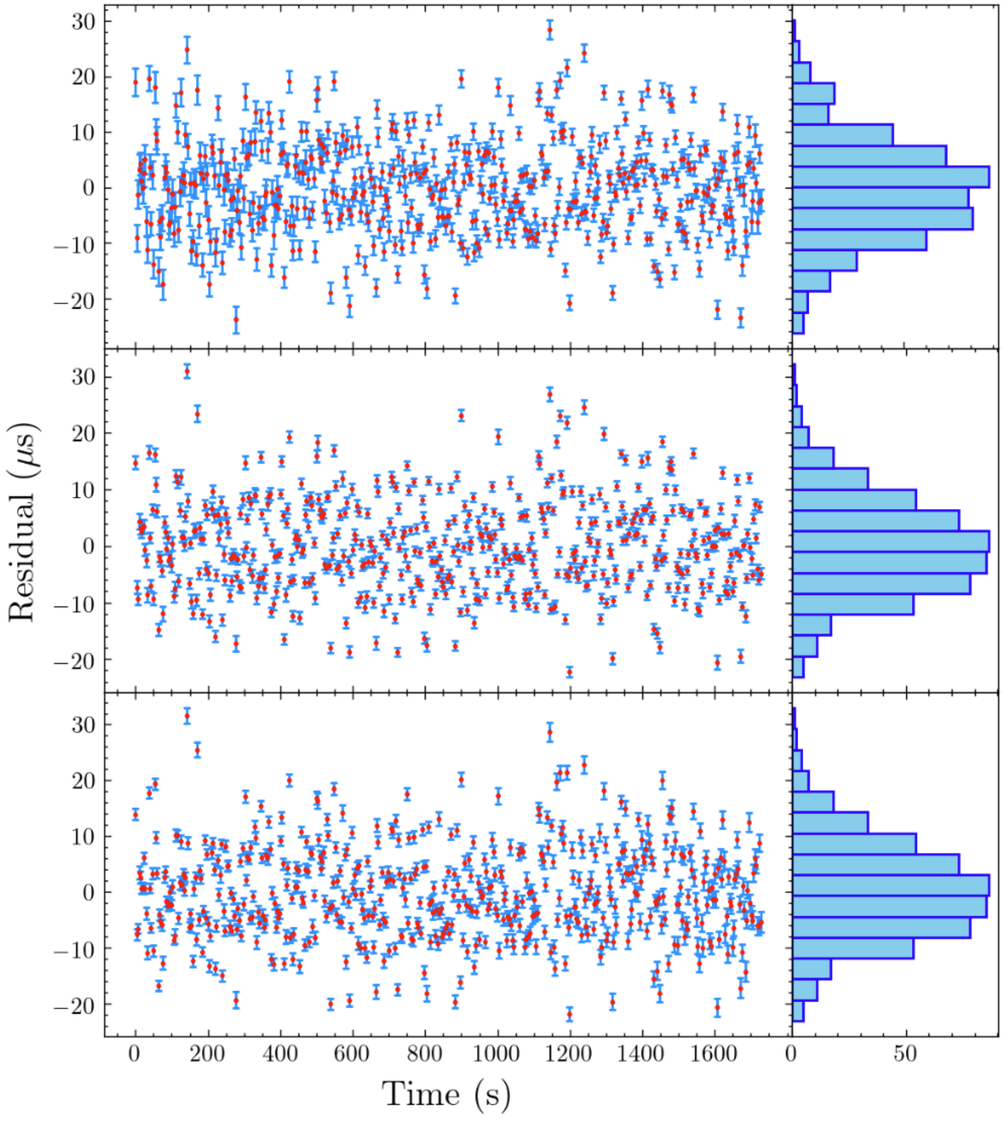
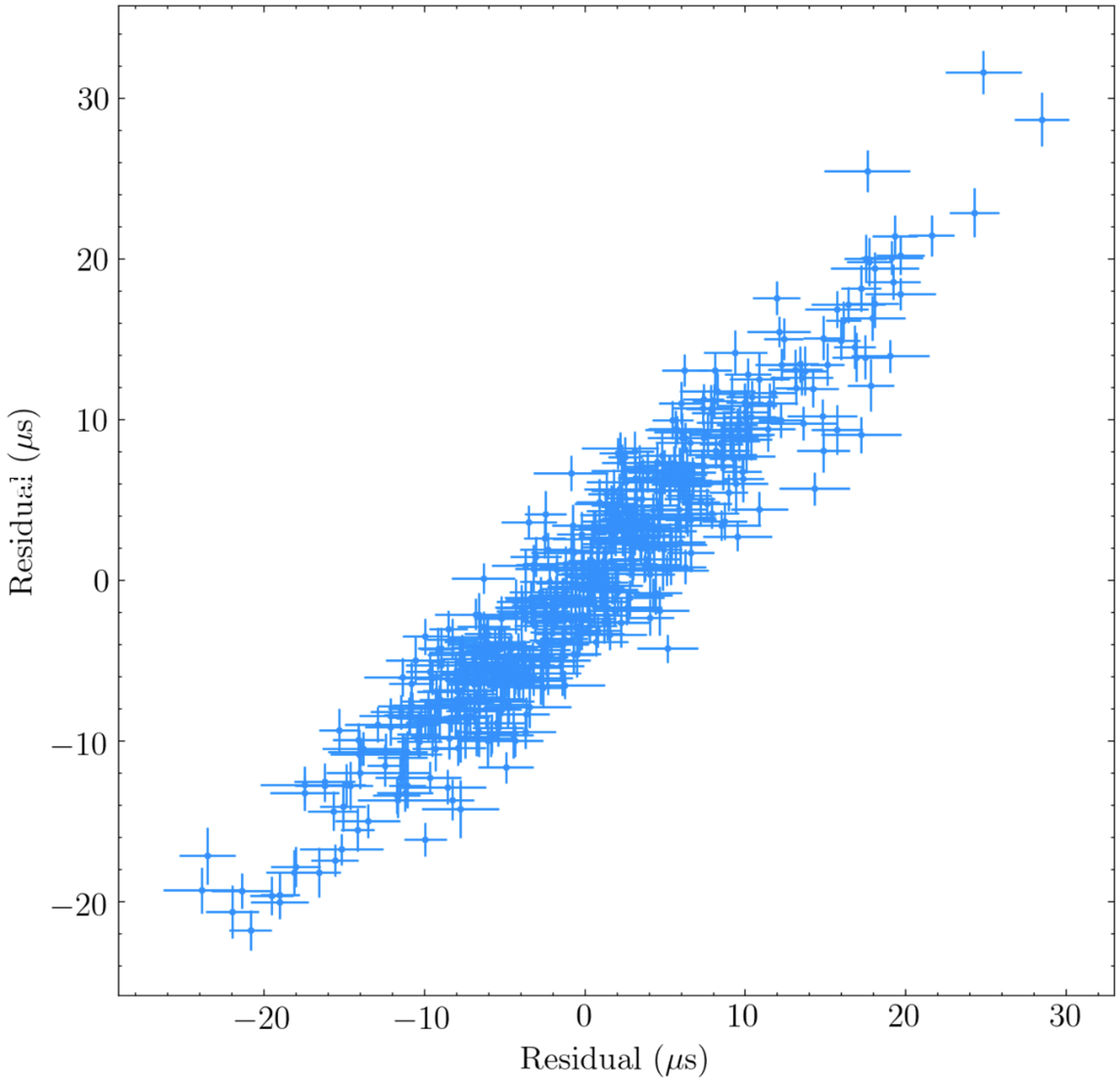
Jitter analysis of PSR J2222-0137





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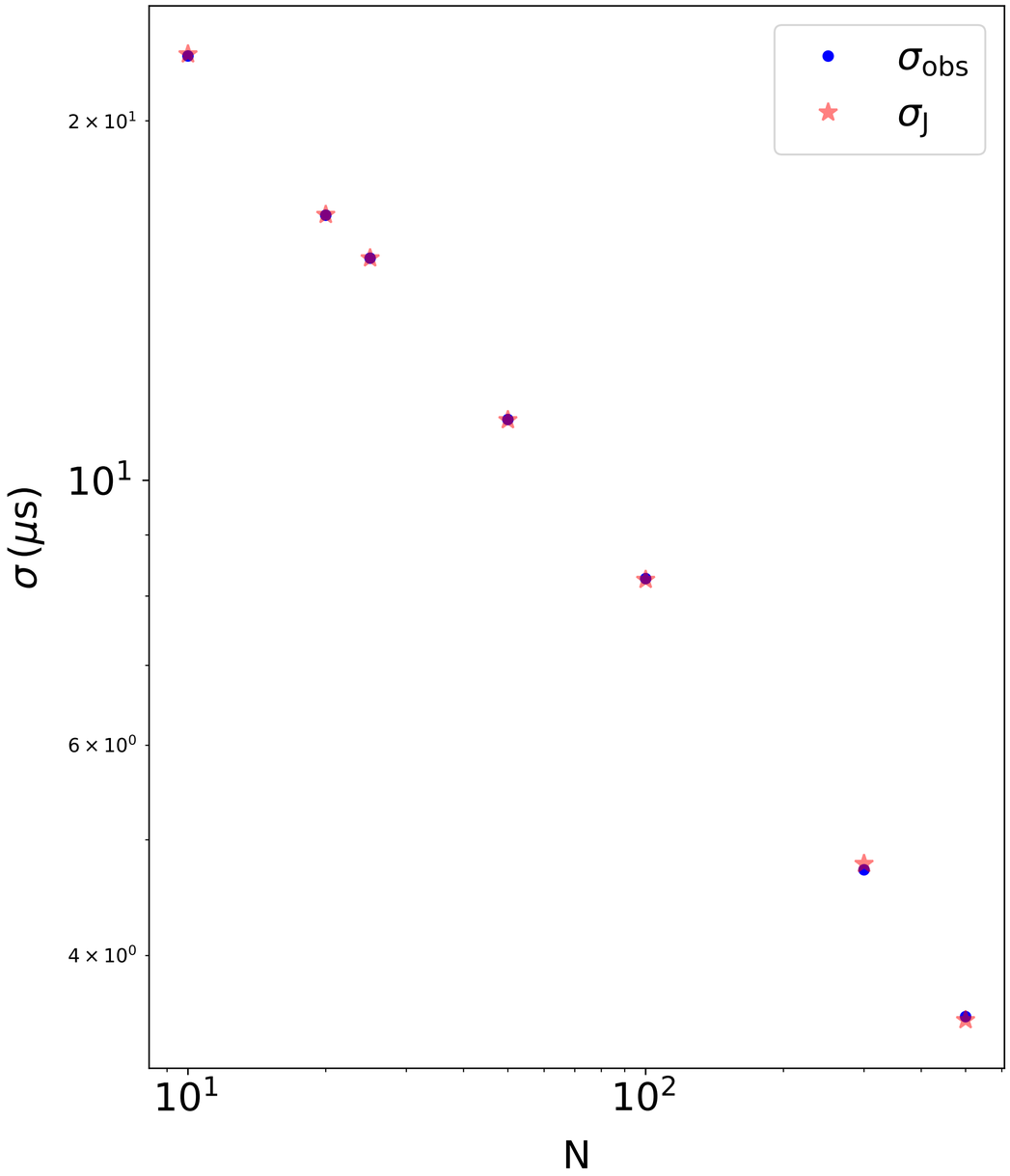
Jitter analysis of PSR J2222-0137



Single pulse ~70 μs

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Thank you!